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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
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EXAMINER

LEE, HSIEN MING

ART UNIT

PAPER NUMBER

2823

DATE MAILED: 02/06/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/551,233

Applicant(s)

MATSUURA ET AL.

Examiner

Hsien-Ming Lee

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 23 November 2001.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1,2,4-19 and 21-28 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1,2,4-19 and 21-28 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 17 April 2000 is/are: a) ☐ accepted or b) ☒ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☐ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 6.
- 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other:

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DETAILED ACTION

The Status of the Application

1. Claims 3 and 20 were cancelled. Thus, claims 1-2, 4-19, 21-28 are pending in the application.

Grounds of Rejection

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

3. Claims 1, 2, 4-14 and 21-28 are rejected under 35 U.S.C. 103(a) as being unpatentable over Cuchiaro et al. (US 6,165,802) in view of Solayappan et al. (US 6,245,580) and Ushikubo et al. (US 5,851,841).

Referring to figs. 1-5 and related text, Cuchiaro et al. teach the claimed method of fabricating a semiconductor device having a ferroelectric capacitor 118, comprising the steps of :

- * forming an active device element 110 on a substrate 102 (fig. 1);
- * forming an insulation film 114 over said substrate 102 to cover said active device element 110 (fig. 1);
- * forming a lower electrode layer 120 of said ferroelectric capacitor 118 over said insulation film 114, wherein said lower electrode layer includes depositing a Ti layer 116 and a Pt layer 120;

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- * forming a ferroelectric film, such as PZT, 122, on said lower electrode 120 as a capacitor insulation film of said ferroelectric capacitor 118 (fig. 1);
- * crystallizing said ferroelectric film 122 by applying a rapid thermal annealing process in an atmosphere containing an oxidizing gas, such as oxygen, under a reduced total pressure smaller than an atmospheric pressure (col. 8, lines 20-30); and
- * forming an upper electrode layer 124 on said ferroelectric film 122 (fig. 1), wherein said method further comprises the step, after said step of crystallizing said ferroelectric film, of oxidizing said ferroelectric film in an oxidizing atmosphere (col. 8, 28-30).

Cuchiaro et al. do not teach that the step of thermal annealing process is in an atmosphere containing a non-oxidizing gas besides an oxidizing gas.

Sonlayappan et al. in an analogous art teach forming a ferroelectric film such as layer 124 on a lower electrode layer 122 as a capacitor insulation film of a ferroelectric capacitor; and crystallizing the ferroelectric film 124 by applying a thermal annealing process in air (col. 8, lines 22-32) which is an atmosphere containing a non-oxidizing gas such as nitrogen and an oxidizing gas such as oxygen, which is 21 % volume fraction in air.

At the time of the invention, it would have been obvious to one of ordinary skill in the art at the time of the invention to combine the annealing atmosphere of Sonlayappan with Cuchiaro's method of fabricating a semiconductor device.

The motivation for doing so would be to produce a satisfactory ferroelectric film for ferroelectric capacitor.

Regarding to claim 11, Ushikubo in an analogous art of annealing a ferroelectric film teach crystallizing the ferroelectric film by applying a thermal annealing in an atmosphere of a

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non-oxidizing gas such as nitrogen or argon and an oxidizing gas such as oxygen, which can be conducted under a reduced total pressure (col. 7, lines 29-63; col. 10, lines 19-23).

4. Claims 15-20 are rejected under 35 U.S.C. 103(a) as being unpatentable over the Izuha et al. (US 6,060,735) in view of Duncombe et al. (US 6,172,385).

Izuha et al. (fig. 1-7) teach the claimed semiconductor device, comprising a semiconductor substrate 1; a lower electrode 4 provided over the semiconductor substrate 1; a ferroelectric film 5 on said lower electrode 4 (fig. 1), said ferroelectric film 5 (perovskite structure such as PZT; col. 4, lines 52-53) having a columnar microstructure extending from an interface between said lower electrode 4 and said ferroelectric film 5 (fig. 4A) in a direction substantially perpendicular to a principal surface of said lower electrode 4 (col. 2, line 57 through col. 3, line 45), said ferroelectric film 5 essentially consisting of crystal grains having a generally uniform grain diameter of less than about 200 nm (col. 6, lines 52-53); and an upper electrode 6 provided on said ferroelectric film 5; wherein said lower electrode 4 comprises a Ti layer and a Pt layer (col. 4, lines 37-45).

Izuha et al. does not teach that the semiconductor substrate comprises an active device element and an insulation film.

Duncombe et al. ('385) in an analogous art teach that the term " substrate" is used broadly to denote any semiconductor wafer or material which may contain active device regions embedded therein as well as an insulator layer on its upper surface (col. 2, lines 27-30).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to appreciate that the semiconductor device of Izuha can be formed on a semiconductor

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substrate comprising an active device element and an insulation film formed thereon as taught by Duncombe, since it is a widely used practice in the art.

Response to Arguments

5. Applicant's arguments filed 11/23/01 have been fully considered but they are not persuasive.

Applicants argues that Soayappan is directed completely to SBT films which is a superlattice material and is a different structure from the PZT crystal structure. Applicants, therefore, asserts that the thermal annealing process of Soayappan will not work with PZT (first paragraph, page 5)

Contrary to the arguments, PZT has the same crystal structure as that of SBT, i.e. superlattice structure (col.1, lines 28-31). Since the ferroelectric film of Cuchiaro can be PZT (col. 5, lines 53-58), it would have been obvious to one of the ordinary skill in the art to apply the thermal annealing of Soayappan, which works with SBT, to Cuchiaro's teachings with a reasonable expectation of success.

Applicants further argues that Izuha reference is not enabling as to PZT and that Duncombe does not provide any PZT teachings. Thus, applicants maintain that the combination of Izuha and Duncombe has not established the *prima facie* obviousness. (third paragraph, page 6).

In response to the arguments, Izuha teaches that " depending on the application of the thin film dielectric device, a relevant perovskite oxide having the function of dielectric is used," and that " when the thin film dielectric device is used for a FRAM, a **ferroelectric** perovskite oxide such as $\text{Pb}(\text{Zr},\text{Ti})\text{O}_3$ (**PZT**) **is used.**" (col. 4, lines 46-53) (emphasis added)

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memory) (col. 1, lines 38-39) and teaches the same ferroelectric material, i.e. perovskite oxide such as lead zirconate titanate (PZT). (col.2, lines 17-26) In addition, Duncombe teaches that the “ substrate is used broadly to denote any semiconductor wafer or material which may contain active device regions embedded therein as well as an insulator layer on its upper surface.” (col. 2, lines 27-30).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to appreciate that the semiconductor device of Izuha can be formed on a semiconductor substrate comprising an active device element and an insulation film formed thereon as taught by Duncombe, since it is a widely used combination in the art, i.e. a semiconductor substrate having the combination of the active device element and the insulation film formed thereon. The teaching of Duncombe would remedy the deficiency of Izuha.

For the reasons above, the rejection as set forth in the previous Office Action is deemed proper.

Conclusion

6. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event,

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however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

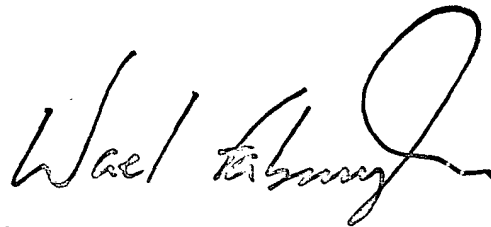
7. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Hsien-Ming Lee whose telephone number is 703-305-7341. The examiner can normally be reached on M-F (9:00 ~ 5:00).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Wael Fahmy can be reached on 703-308-4918. The fax phone numbers for the organization where this application or proceeding is assigned is 703-305-3432.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.



Hsien Ming Lee
January 29, 2002



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